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Information Sharing of Energy Sources Supply Chain

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Abstract

Energy sources supply chain is a new research concern in supply chain management. Supply chain coordination leads to increased information flow, reduced uncertainty, which has become a critical success factor for energy sources supply chain management. We study the energy sources supply chain consisting of one energy sources vendor (SV) and one energy sources integration provider (SIP). We develop information sharing coordination of energy sources supply chain between the SV and the SIP. We try to explore the information sharing coordination in energy sources supply chain which is classified into different information flows. The findings reinforce the importance of information sharing coordination and performance to companies. As a last note, future research direction is pointed out.

Keywords: energy sources supply chain; energy sources vendor; energy sources integration provider; information sharing; coordination

1. Introduction

Energy sources are significant, and spend is large and growing. Attention to the energy sources supply chain by practitioners is necessary for improvement and minimization of value leakage. Similarly, more attention to the energy sources supply chain is needed by academics as they educate future practitioners and conduct research. Disseminating information on best practices and trends in managing the energy sources supply chain and energy sources purchases could help businesses retain their competitive advantage in the growing global economy (Ellram et al., 2004). Improved management of energy sources

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spending could represent the next major area of cost reduction and value enhancement for organizations. When supply chain members are separate and independent economic entities, this action plan has to include an incentive scheme to allocate the benefits from coordination among them so as to entice their cooperation (Li & Wang, 2007). Information coordination is a key approach to achieve supply chain coordination.

Recently, academic researchers have showed a growing interest in the value of information sharing in supply chain. The marketing literature on supply chain coordination focuses on pricing decision without inventory replenishment considerations, e.g. Abel P. Jeuland and Steven M. Shugan addressed the problem of coordinating channel decisions, which showed that quantity discounts are profitable even with no order or inventory costs (Jeuland & Shugan, 2008). Charles A. Ingene Mark E. Parr explored wholesale pricing behavior within a two-level vertical channel consisting of a manufacturer selling through multiple independent retailers (Parry, 1995). Gérard P. Cachon and Martin A. Lariviere studied contracts that allow the supply chain to share demand forecasts credibly under either compliance regime (Cachon & Lariviere, 2001). It is obvious that utilizing timely and accurate information about demand and adjacent players is the best way to cope with the various uncertainties of the supply chain (Yao et al., 2008; Demirkan & Cheng, 2008;Chen et al., 2006). While the value of information sharing is widely recognized, we want to develop how information sharing affects supply chain performance, what types of information supply chain members should share, and how they should share it.

2. Mathematical functions

In the paper we consider the benefits of information sharing and ignore the technology cost involved. To provide energy sources volume for customers, the SIP acquires a capacity C of energy sources supplyplan from the SV who charges value V per unit of energy sources outsourcing capacity. Then, the SIP sells the value-add integration energy sources to customers at price P per unit of energy sources request capacity. We can know the result of P>V in order to make a profit about the SIP. Because of a price-sensitive customer energy sources request at market, the SIP faces the actual energy sources request volume w that is a random variable. w is characterized by the probability distribution F(w). Owing to the expected customer energy sources request volume for the SIP energy sources integration plan being affected by the price it changes P, the customer energy sources volume is described by the following Equation. A different pricing will entail a different expected customer energy sources request volume W. In our energy sources supply chain model, we assume that the price-sensitive customer energy sources request volume follows a uniform distribution over the range $[w(p)-\Delta, w(p)+\Delta]$ across time periods for a profit. One might consider using a normal distribution to describe the price-sensitive random volume (Demirkan & Cheng, 2008). The normal distribution is not suitable in this context, as the uniform distribution chosen for analytical tractability. According to above uniform distribution function F(w), the SIP expected profit which excluding marginal capacity costs can be defined by

$$\Psi_{SIP} = \int_{w(p)-\Delta}^{C} [(P-V)w]F(w)dw + \int_{C}^{w(p)+\Delta} [(P-V)C]F(w)dw = \frac{-(P-V)C^2 + 2(P-V)[w(p)+\Delta]C - (P-V)[w(p)-\Delta]^2}{4\Delta}$$

$$= -\frac{P-V}{4\Delta}[C^2 - 2(w(p)+\Delta)C + (w(p)-\Delta)^2] = -\frac{P-V}{4\Delta}[C-(w(p)+\Delta)]^2 - (P-V)w(p)$$

The equation describes the expected profit when actual customer energy sources request volume is below or above the capacity C of energy sources supply plan from the SV. The fluctuating income for SV can be computed by the capacity C, multiplied by per unit of capacity, V. Moreover, the cost structure of SV has two components consisting of per unit cost of capacity described by the parameter m which reflects the constant economy of scale in energy sources (Mendelson, 1987); a diseconomy of scale cost parameter n, related to the management of infrastructure results from increasing cost of managing capacity and rising complexity of the business model (Cotton, 1975; Rubens, 2001). Hence, the SV's profit function is defined as $\Psi_{sv} = CV - mC - nC^2$. Because of the random character of customer energy sources request volume, costs associated with energy sources ordering will raise more or less capacity of volume for the SIP and the SV. With regard to this, we assume more or less capacity cost of volume as follow, $L(w) = \int_{C}^{w(p)+\Delta} \zeta(w-C)F(w)dw = \frac{\zeta}{2\Delta}[\frac{C^2}{2} - C(w(p)+\Delta) + \frac{(w(p)+\Delta)^2}{2}] = \frac{\zeta}{4\Delta}[C-(w(p)+\Delta)]^2$

$M(w) = \int_{w(p)-\Delta}^{C} [(V-\xi)(C-w)]F(w)dw = \frac{V-\xi}{2\Delta}[C^2 - C(w(p)-\Delta) - \frac{C^2}{2} + \frac{(w(p)-\Delta)^2}{2}] = \frac{V-\xi}{4\Delta}[C-(w(p)-\Delta)]^2$ where the function $M(w)$ represents the expected over-capacity cost of volume, and the function $L(w)$ represents the expected under-capacity cost of volume. The parameter ξ represents the salvage value of unused capacity and the parameter ζ represents the opportunity cost of lost sales due to insufficient capacity depending on industry characteristic.

3. Information sharing coordination scenario

Information revelation mechanism design is an important topic in economic management, in particular, in supply chain management (Xiao & Yang, 2009). In this paper, we consider two information sharing coordination scenarios including: monocyclic information sharing coordination, SIP coordination information transferring scenario, SV coordination information distributing scenario, as shown below.

In first scenario, the SV and the SIP negotiate to reach a mutually agreeable policy. With respect to the SV, the maximized profit function can achieve from the equation $\Psi_{sv} = CV - mC - nC^2$. When $\frac{d\Psi}{dC} = 0$, the optimal capacity C is defined as $C_{SV} = \frac{V-m}{2n}$. The capacity C of energy sources supply plan from the SV is optimal energy sources volume to sell to the SIP. However, the SIP will find the optimal volume it wants to buy from the SV. Since the SIP bears the risk of the supply chain in monocyclic information sharing coordination, the more or less capacity costs of volume are included in the SIP's profit function as follows: $E_{SIP} = \Psi_{SIP} - M(w) - L(w)$ .Instead, the SV derives the price-capacity schedule by finding the optimal energy sources volume that maximizes its profit function described by $V = m + 2nC$. Then, given the per unit capacity price V, the SIP's profit function requires that

$\frac{\partial E}{\partial C} = -\frac{P-V}{4\Delta}[2C - 2(w(p)+\Delta)] - \frac{V-\xi}{4\Delta}[2C - 2(w(p)-\Delta)] - \frac{\zeta}{4\Delta}[2C - 2(w(p)+\Delta)] = 0$ and $\frac{\partial E}{\partial p} = 0$ For a given per unit capacity price V, let C_{SIP} be the optimal energy sources volume for the SIP satisfying the above equation after some algebra. Then $C_{SIP} = \frac{-2V\Delta - \xi(w(p)-\Delta) + (\zeta+P)(w(p)+\Delta)}{P-\xi+\zeta}$. That is, it represents the optimal energy sources volume that the SIP wants to buy from the SV. With respect to capacity equilibrium of the whole supply chain, the energy sources outsourcing volume the SIP want to buy will be the same as the volume the SV desires to sell. In other words, it should yield to feasible solution of V for both the SIP and the SV to reach an agreement, namely, $C_{SV} = C_{SIP}$. Because of $\frac{dC_{SV}}{dV} = \frac{1}{2n} > 0$ when n>0, C_{SV} is a strictly increasing function of V and $\frac{dC_{SIP}}{dV} = \frac{-2\Delta}{p-\xi+\zeta} < 0$ when $\Delta > 0$, C_{SIP} is a strictly decreasing function of V. Thus there is a unique solution in monocyclic information sharing coordination.

In another coordination strategy, there exists asymmetric information between the SIP and the SV. The price-sensitive random demand information and ordering decisions are closed to the SV. The SV coordinates the energy sources supply chain and bears the risk of more or less capacity costs. Thus, the SIP takes the purchase cost of per unit energy sources volume capacity V as given and optimizes its expected profit as follows, $\Psi_{SIP} = -\frac{P-V}{4\Delta}[C-(w(p)+\Delta)]^2 - (P-V)w(p)$ .When the SIP does not bear the risk of more or less energy sources volume capacity cost, it always orders the capacity up to the maximum limit of the customer's request. The higher the SV charges the SIP per unit capacity V, the higher the price the SIP will charge the customers. Meanwhile, the energy sources capacity the SIP will order from the SV, C^* and the price the SIP which will charge to the customers P^* will be communicated to the SV. Based on this information, the SV determines the optimal per unit capacity price V^* that maximizes its profit by considering more or less energy sources capacity costs as follow, $\Psi^*_{SV} = \Psi(C^*) - M(w^*) - L(w^*)$.

The objective function of the SV should be apparent that the SV only needs to be concerned with more energy sources volume cost when the SIP orders the maximum possible energy sources volume the customers would consume, which has incorporated the information disclosed from the SIP. However, when the SV coordinates the supply chain by taking the risk, the SIP will order the maximum limit of the customers energy sources request volume, $w(p^*)+\Delta$. When the SV is coordinating the supply chain, the optimal per unit price of capacity the SV should charge the SIP. The total supply chain profit is thus given by: $\Gamma^* = -\frac{P^*-V^*}{4\Delta}[C^*-(w(p^*)+\Delta)]^2 - (P^*-V^*)w(p^*) + \Psi(C^*) - M(w^*) - L(w^*)$

4. Conclusions

In this research, the paper attempts to illustrate the benefits of energy sources supply chain partnerships with information sharing. The partnerships between the SV and the SIP are defined in terms of three information sharing levels. We analyses the energy sources supply chain's performance under three different coordination strategies involving coordination and information sharing between the SV and the SIP. However, our research has some limitations. In reality, the SV sells energy sources volume to multiple SIP's facing the same customers. The interaction between the SV and the SIP may be different when there are multiple SIP's competing for the same customers, the price-sensitive customer energy sources request volume in our models follows a uniform distribution for analytical tractability reason. It is worthwhile to resolve these limitations for future research.

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